PB-239 574

CLEARWATER LAKE, WRIGHT AND STEARNS COUNTIES, MINNESOTA

Pacific Northwest Environmental Research Laboratory

Prepared for:

National Environmental Research Center
Minnesota National Guard
Minnesota Pollution Control Agency

December 1974

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16. ABSTRACT

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivded according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

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Report

on

Clearwater Lake

Wright and Stearns Counties

Minnesota

EPA Region V

Working Paper No. 93

With the cooperation of the

Minnesota Pollution Control Agency

and the

Minnesota National Guard

December, 1974

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to fresh water lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Minnesota Pollution Control Agency for professional involvement and to the Minnesota National Guard for conducting the tributary sampling phase of the Survey.

Grant J. Merritt, Director of the Minnesota Pollution Control Agency, John F. McGuire, Chief, and Joel G. Schilling, Biologist, of the Section of Surface and Groundwater, Division of Water Quality, provided invaluable lake documentation and counsel during the course of the Survey; and the staff of the Section of Municipal Works, Division of Water Quality, were most helpful in identifying point sources and soliciting municipal participation in the Survey.

Major General Chester J. Moeglein, the Adjutant General of Minnesota, and Project Officer Major Adrian Beltrand, who directed the volunteer efforts of the Minnesota National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

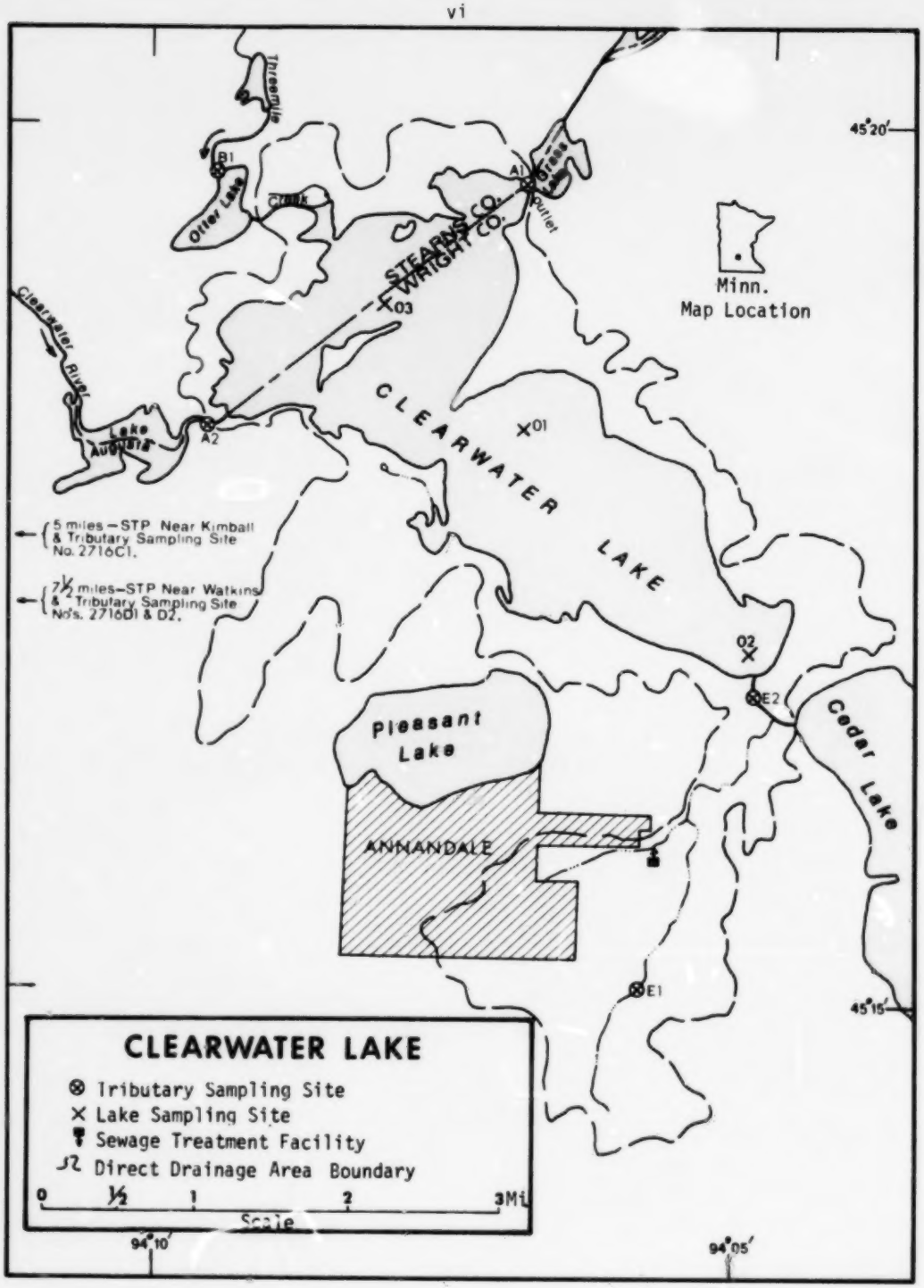
NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF MINNESOTA

LAKE NAME	COUNTY
Albert Lea	Freeborn
Andrusia	Beltrami
Badger	Polk
Bartlett	Koochiching
Bear	Freeborn
Bemidji	Beltrami
Big	Stearns
Big Stone	Big Stone, MN; Roberts, Grant, SD
Birch	Cass
Blackduck	Beltrami
Blackhoof	Crow Wing
Budd	Martin
Buffalo	Wright
Calhoun	Hennepin
Carlos	Douglas
Carrigan	Wright
Cass	Beltrami, Cass
Clearwater	Wright, Stearns
Cokato	Wright
Cranberry	Crow Wing
Darling	Douglas
Elbow	St. Louis
Embarass	St. Louis
Fall	Lake
Forest	Washington
Green	Kandiyohi
Gull	Cass
Heron	Jackson
Leech	Cass
Le Homme Dieu	Douglas
Lily	Blue Earth
Little	Grant
Lost	St. Louis

LAKE NAME	COUNTY
Madison	Blue Earth
Malmedal	Pope
Mashkenode	St. Louis
McQuade	St. Louis
Minnetonka	Hennepin
Minnewaska	Pope
Mud	Itasca
Nest	Kandiyohi
Pelican	St. Louis
Pepin	Goodhue, Wabasha, MN; Pierce, Pepin, WI
Rabbit	Crow Wing
Sakatah	Le Sueur
Shagawa	St. Louis
Silver	McLeod
Six Mile	St. Louis
Spring	Washington, Dakota
St. Croix	Washington, MN; St. Croix, Pierce, WI
St. Louis Bay	St. Louis, MN; Douglas, WI
Superior Bay	St. Louis, MN; Douglas, WI
Swan	Itasca
Trace	Todd
Trout	Itasca
Wagonga	Kandiyohi
Wallmark	Chisago
White Bear	Washington
Winona	Douglas
Wolf	Beltrami, Hubbard
Woodcock	Kandiyohi
Zumbro	Olmstead, Wabasha


CLEARWATER LAKE
Tributary Sampling Site
Lake Sampling Site
Sewage Treatment Facility
Direct Drainage Area Boundary
0 ½ 1 2 3Mi
Scale
Minn.
Map Location
45°20′
45°15′
94°10′
94°05′
STEARNS CO.
WRIGHT CO.
CLEARWATER LAKE
Pleasant Lake
ANNANDALE
Cedar Lake
Otter Lake
Lake Augusta
Clearwater River
Threemile Creek
Outlet
B1
A1
A2
E1
E2
01
02
03
5 miles—STP Near Kimball & Tributary Sampling Site No. 2716C1.
7½ miles—STP Near Watkins & Tributary Sampling Site No's. 2716D1 & D2.

CLEARWATER LAKE

STORET NO. 2716

I. CONCLUSIONS

A. Trophic Condition:

Survey data indicate that Clearwater Lake is eutrophic. Although nutrient levels were low when compared to all other Minnesota lakes studied, Clearwater Lake has an aquatic vegetation problem. Survey limnologists indicated that the shallow and shoreline areas were heavily grown with rooted vegetation. Also, algal blooms were noted on the July and August sampling periods along with surface plant debris and hydrogen sulfide in samples from the hypolimnion.

B. Rate-Limiting Nutrient:

The algal assay sample was lost in shipment from the field; therefore, no assay results are available. The lake data indicate the lake was nitrogen limited during all three sampling periods.

C. Nutrient Controllability:

1. Point sources--During the sampling year, it is calculated that Clearwater Lake received a total phosphorus load at a rate in excess of the rate proposed by Vollenweider (in press) as "dangerous"; i.e., a eutrophic rate (see page 12). Of this load,

it is estimated that about 36% was contributed by the communities of Watkins and Kimball.

It is calculated that even complete removal of phosphorus at the indicated point sources would result in a loading rate of 3.8 lbs/acre/yr or 0.43 $g/m^2/yr$--a rate still somewhat in excess of the eutrophic rate of 0.38 $g/m^2/yr$. However, if such a degree of removal can be achieved, it is likely there would be some improvement in the trophic condition of Clearwater Lake.

2. Non-point sources (see page 12)--The phosphorus export of the Clearwater River was about three times that of the other two tributaries to Clearwater Lake and may have been due to underestimation of the phosphorus loads from Watkins and Kimball.

In all, it is estimated that non-point sources contributed about 63% of the total phosphorus load to Clearwater Lake during the sampling year.

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS

A. Lake Morphometry†:

1. Surface area: 3,182 acres.
2. Mean depth: 17 feet.
3. Maximum depth: 75 feet.
4. Volume: 54,094 acre/feet.
5. Mean hydraulic retention time: 1.4 years.

B. Tributary and Outlet:
(See Appendix A for flow data)

1. Tributaries -

Name	Drainage area*	Mean flow*
Clearwater River	100.0 mi^2	31.1 cfs
Three Mile Creek	16.8 mi^2	5.8 cfs
Unnamed Creek	21.6 mi^2	6.3 cfs
Minor tributaries & immediate drainage -	30.6 mi^2	11.5 cfs
Totals	169.0 mi^2	54.7 cfs

2. Outlet -

Clearwater River	174.0 mi^2**	54.7 cfs

C. Precipitation***

1. Year of sampling: 24.3 inches.
2. Mean annual: 28.8 inches.

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† DNR lake survey map (1958); mean depth from DNR personnel.
* Drainage areas are accurate within ±5%; mean daily flows are accurate within ±10%; and ungaged flows are accurate within ±10 to 25% for drainage areas greater than 10 mi^2.
** Includes area of lake.
*** See Working Paper No. 1, "Survey Methods".

III. LAKE WATER QUALITY SUMMARY

Clearwater Lake was sampled three times during the open-water season of 1972 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from three stations on the lake and from a number of depths at each station (see map, page vi). During each visit, a single depth-integrated (15 feet to surface) sample was composited from the three stations for phytoplankton identification and enumeration; and during the last visit, a single five-gallon depth-integrated sample was composited for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analysis. The maximum depths sampled were 49 feet at station 1, 28 feet at station 2, and 34 feet at station 3.

The results obtained are presented in full in Appendix B, and the data for the fall sampling period, when the lake essentially was well-mixed, are summarized below. Note, however, the Secchi disc summary is based on all values.

For differences in the various parameters at the other sampling times, refer to Appendix B.

A. Physical and chemical characteristics:

Parameter	Minimum	Mean	Median	Maximum
		FALL VALUES (10/27/72)		
Temperature (Cent.)	6.6	7.1	7.1	7.5
Dissolved oxygen (mg/l)	10.2	11.0	11.0	11.8
Conductivity (μmhos)	340	379	363	420
pH (units)	8.0	8.1	8.1	8.1
Alkalinity (mg/l)	143	161	155	182
Total P (mg/l)	0.017	0.035	0.029	0.059
Dissolved P (mg/l)	0.010	0.021	0.013	0.038
NO_2 + NO_3 (mg/l)	0.030	0.049	0.040	0.090
Ammonia (mg/l)	0.030	0.077	0.050	0.140
		ALL VALUES		
Secchi disc (inches)	36	62	60	94

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Number per ml
07/03/72	1. Dinobryon	877
	2. Anabaena	217
	3. Oocystis	181
	4. Cyclotella	154
	5. Fragilaria	145
	Other genera	189
	Total	1,763
08/29/72	1. Anabaena	789
	2. Dinobryon	738
	3. Melosira	195
	4. Microcystis	181
	5. Cryptomonas	65
	Other genera	261
	Total	2,229
10/27/72	1. Chroococcus	26,181
	2. Flagellates	3,417
	3. Melosira	1,357
	4. Anabaena	1,106
	5. Dinobryon	754
	Other genera	3,667
	Total	36,482

2. Chlorophyll a -
(Because of instrumentation problems during the 1972 sampling, the following values may be in error by plus or minus 20 percent.)

Sampling Date	Station Number	Chlorophyll a (μg/l)
07/03/72	01	9.0
	02	6.2
	03	2.0
08/29/72	01	4.4
	02	3.5
	03	20.4
10/27/72	01	31.5
	02	28.9
	03	20.9

C. Limiting Nutrient Study:

The algal assay sample was lost in shipment from the field, therefore, no assay results are available. Lake data indicate that the lake was nitrogen limited during all three sampling periods.

IV. NUTRIENT LOADINGS
(See Appendix C for data)

For the determination of nutrient loadings, the Minnesota National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page vi), except for the high runoff month of April when two samples were collected. Sampling was begun in October, 1972, and was completed in October, 1973.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Minnesota District Office of the U.S Geological Survey for the tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries were determined by using a modification of a U.S. Geological Survey computer program for calculating stream loadings*. Nutrient loading for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated by using the means of the nutrient loads, in lbs/mi^2/year, at station B-1 and multiplying the means by the ZZ area in mi^2.

The operator of the Watkins wastewater treatment plant provided monthly effluent samples and corresponding flow data. However, Kimball did not participate in the Survey, and nutrient loads were estimated at 2.5 lbs P and 7.5 lbs N/capita/year.

The tributary nutrient loads given in the following tables are those measured minus point sources, if any.

* See Working Paper No. 1.

The waste treatment facilities of the Village of Annandale consist of a stabilization pond with effluent disposal by ridge and furrow irrigation since 1970. Nutrient loads measured downstream from the treatment facilities indicate little or no discharge of nutrients from the system during the sampling year.

A. Waste Sources:

1. Known municipal† -

Name	Pop. Served	Treatment	Mean Flow (mgd)	Receiving Water
Watkins	785	trickling filter	0.200	Clearwater River
Kimball	567	trickling filter	0.057*	Clearwater River
Annandale	1,234	stab. pond + land disposal	0.123*	Unnamed stream

2. Known industrial - None

† Anonymous, 1974.
* Estimated at 100 gal/capita/day.

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	lbs P/ yr	% of total
a. Tributaries (non-point load) -		
Clearwater River	9,290	48.8
Three Mile Creek	480	2.5
Unnamed Creek (E-2)	820	4.3
b. Minor tributaries & immediate drainage (non-point load) -	890	4.7
c. Known municipal -		
Watkins	5,500	28.8
Kimball	1,420	7.4
Annandale	-	-
d. Septic tanks* -	130	0.7
e. Known industrial - None	-	-
f. Direct precipitation** -	500	2.8
Total	19,130	100.0

2. Outputs -

Lake outlet - Clearwater River 4,490

3. Net annual P accumulation - 14,640 pounds

* Estimate based on 209 shoreline dwellings; see Working Paper No. 1.
** See Working Paper No. 1.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	lbs N/yr	% of total
a. Tributaries (non-point load) -		
Clearwater River	116,800	49.5
Three Mile Creek	15,690	6.6
Unnamed Creek (E-2)	19,470	8.2
b. Minor tributaries & immediate drainage (non-point load) -	28,580	12.1
c. Known municipal -		
Watkins	15,930	6.7
Kimball	4,250	1.8
Annandale	-	-
d. Septic tanks* -	4,910	2.1
e. Known industrial - None	-	-
f. Direct precipitation** -	30,660	13.0
Total	236,290	100.0

2. Outputs -

Lake outlet - Clearwater River 130,510

3. Net annual N accumulation - 105,780 pounds

* Estimate based on 209 shoreline dwellings; see Working Paper No. 1.
** See Working Paper No. 1.

D. Mean Annual Non-point Nutrient Export by Subdrainage Area:

Tributary	lbs $P/mi^2/yr$	lbs $N/mi^2/yr$
Clearwater River	93	1,168
Three Mile Creek	29	934
Unnamed Creek (E-2)	38	901

E. Yearly Loading Rates:

In the following table, the existing phosphorus loading rates are compared to those proposed by Vollenweider (in press). Essentially, his "dangerous" rate is the rate at which the receiving waters would become eutrophic or remain eutrophic; his "permissible" rate is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic rate would be considered one between "dangerous" and "permissible".

	Total Phosphorus		Total Nitrogen	
Units	Total	Accumulated	Total	Accumulated
lbs/acre/yr	6.0	4.5	74.3	33.2
grams/m^2/yr	0.67	0.52	8.3	3.7

Vollenweider loading rates for phosphorus ($g/m^2/yr$) based on mean depth and mean hydraulic retention time of Clearwater Lake:

"Dangerous" (eutrophic rate)	0.38
"Permissible" (oligotrophic rate)	0.19

V. LITERATURE REVIEWED

Anonymous, 1974. Wastewater disposal facilities inventory. MPCA, Minneapolis.

Schilling, Joel, 1974. Personal communication (lake morphometry and map). MPCA, Minneapolis.

Vollenweider, Richard A. (in press). Input-output models. Schweiz. A. Hydrol.

VII. APPENDICES

APPENDIX A

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR MINNESOTA 10/30/74

LAKE CODE 2716 CLEARWATER LAKE

TOTAL DRAINAGE AREA OF LAKE 174.00

NORMALIZED FLOWS

TRIBUTARY	SUB-DRAINAGE AREA	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
271681	174.00	11.20	12.80	39.30	149.50	101.30	101.30	65.50	46.60	51.40	30.50	27.00	19.90	54.73
271682	100.00	6.31	6.49	23.00	85.20	58.00	59.40	37.60	25.30	29.80	16.50	14.30	10.90	31.07
271681	16.80	1.83	1.74	5.25	13.10	10.30	10.20	6.84	4.80	6.36	3.33	2.64	2.90	5.79
271652	21.60	0.84	0.90	3.94	17.00	12.30	13.00	8.09	4.98	6.89	3.37	2.68	1.97	6.34
271622	35.40	2.01	2.09	6.67	40.60	22.50	23.30	13.80	8.90	11.80	6.99	5.60	3.95	11.53

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 174.00
SUM OF SUB-DRAINAGE AREAS = 173.80

TOTAL FLOW IN = 656.05
TOTAL FLOW OUT = 656.30

MEAN MONTHLY FLOWS AND DAILY FLOWS

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
271681	10	72	93.70	14	97.00				
	11	72	87.20	11	102.00				
	12	72	68.90	9	41.00				
	1	73	31.70	6	43.00				
	2	73	22.90	3	28.00				
	3	73	166.00	11	75.00				
	4	73	140.00	7	162.00	17	126.00		
	5	73	109.00	5	117.00				
	6	73	82.40	10	90.00				
	7	73	135.00	14	138.00				
	8	73	44.40	11	54.00				
	9	73	42.90						
271682	10	72	50.10	14	52.00				
	11	72	45.30	11	53.00				
	12	72	37.10	9	22.00				
	1	73	16.70	6	23.00				
	2	73	11.40	3	11.00				
	3	73	95.20	11	43.00				
	4	73	78.40	7	91.00	17	71.00		
	5	73	61.50	5	66.00				
	6	73	47.50	10	51.00				
	7	73	75.90	14	77.00				
	8	73	23.70	11	27.00				
	9	73	24.40						

LAKE CODE 2716 CLEARWATER LAKE

MEAN MONTHLY FLOWS AND DAILY FLOWS

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
2716B1	10	72	10.05	14	10.00				
	11	72	8.37	11	9.80				
	12	72	9.91	9	6.00				
	1	73	5.09	6	6.90				
	2	73	3.13	3	3.80				
	3	73	21.70	11	9.80				
	4	73	12.10	6	14.00	17	11.00		
	5	73	10.90	5	12.00				
	6	73	8.16	10	8.80				
	7	73	13.80	14	14.00				
	8	73	4.51	11	5.80				
	9	73	5.21						
2716E2	10	72	10.20	14	11.00				
	11	72	8.52	11	10.00				
	12	72	6.72	9	4.00				
	1	73	2.47	6	3.30				
	2	73	1.58	3	1.90				
	3	73	16.30	11	7.30				
	4	73	15.60	6	18.00	17	14.00		
	5	73	13.00	5	14.00				
	6	73	10.40	10	11.00				
	7	73	16.30	14	17.00				
	8	73	4.67	11	5.20				
	9	73	5.65						
2716Z2	10	72	21.20	14	22.00				
	11	72	17.80	11	21.00				
	12	72	13.50	9	8.10				
	1	73	5.59	6	7.60				
	2	73	3.68	3	4.40				
	3	73	27.60	11	12.00				
	4	73	28.20	7	33.00	17	25.00		
	5	73	23.80	5	26.00				
	6	73	18.60	10	20.00				
	7	73	27.30	14	29.00				
	8	73	8.37	11	11.00				
	9	73	9.68						

APPENDIX B

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 74/10/30

271601
45 18 12.0 094 06 54.0
CLEARWATER LAKE
27 MINNESOTA

11EPALES 2111202
3 0030 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/07/03	16 05	0000	21.6	9.8	38	305	8.00	140	0.060	0.080	0.024	0.014
	16 05	0010	20.4	7.6		315	7.80	142	0.060	0.070	0.032	0.025
	16 05	0015	17.1	1.4		340	7.30	165	0.050	0.090	0.033	0.017
	16 05	0022	14.0	0.2		345	7.10	178	0.080	0.150	0.026	0.015
	16 05	0030	11.4	1.0		365	7.20	190	0.070	0.360	0.032	0.022
72/08/29	09 25	0000			94	330	8.25	140	0.060	0.070	0.020	0.010
	09 25	0004	21.6	9.0		335	8.30	139	0.050	0.050	0.018	0.009
	09 25	0015	18.7	5.8		340	7.95	136	0.060	0.090	0.015	0.009
	09 25	0021	17.9	1.6		360	7.60	142	0.050	0.160	0.017	0.015
	09 25	0027	16.7	0.0		380	7.40	161	0.100	0.410	0.075	0.022
72/10/27	16 05	0000			72	365	8.00	154	0.040	0.040	0.027	0.012
	16 05	0004	7.5	11.4		360	8.10	154	0.040	0.040	0.024	0.012
	16 05	0015	7.5	11.8		345	8.10	154	0.040	0.050	0.026	0.013
	16 05	0020	7.4	11.0		345	8.10	152	0.040	0.050	0.028	0.014
	16 05	0030	7.4	10.5		345	8.10	143	0.030	0.030	0.021	0.013
	16 05	0040	7.4	10.2		350	8.10	146	0.030	0.030	0.031	0.012
	16 05	0049	7.3	10.8		350	8.00	150	0.030	0.030	0.021	0.012

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/07/03	16 05	0000	9.0J
72/08/29	09 25	0000	4.4J
72/10/27	16 05	0000	31.5J

J VALUE KNOWN TO BE IN ERROR

STORET RETRIEVAL DATE 74/10/30

271602
45 19 00.0 094 05 00.0
CLEARWATER LAKE
27 MINNESOTA

11EPALES
3

2111202
0030 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/07/03	17 05	0000	22.6	10.0	36	300	8.00	135	0.040	0.060	0.043	0.013
	17 05	0015	22.6	[illegible]		335	7.20	174	0.040	0.080	0.025	0.011
	17 05	0022	12.3	5.4		285	8.10	148	0.040	0.750	0.032	0.020
	17 05	0026	15.3	0.6		360	7.10	172	0.050	0.100	0.025	0.012
	17 05	0024	10.5	0.6		360	7.10	190	0.070	0.410	0.059	0.041
72/08/29	09 55	0000			60	355	8.05	148	0.070	0.080	0.034	0.022
	09 55	0004	26.0	4.0		345	8.10	148	0.070	0.080	0.034	0.022
	09 55	0015	18.4	5.6		340	7.95	142	0.070	0.070	0.019	0.010
	09 55	0019	18.6	5.2		340	7.90	143	0.050	0.070	0.021	0.010
72/10/27	15 40	0000			77	360	8.10	153	0.030	0.040	0.020	0.011
	15 40	0004	7.2	10.5		350	8.10	155	0.030	0.030	0.017	0.011
	15 40	0015	7.1	11.3		340	8.10	153	0.030	0.040	0.022	0.010
	15 40	0020	7.1	11.4		356	8.10	153	0.040	0.040	0.021	0.012

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/07/03	17 05	0000	6.2J
72/08/29	09 55	0000	3.5J
72/10/27	15 40	0000	28.9J

J VALUE KNOWN TO BE IN ERROR

STORET RETRIEVAL DATE 72/10/30

271603
45 17 03.0 094 04 06.0
CLEARWATER LAKE
27 MINNESOTA

11FRALFS 2111202
3 002M FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/07/05	18 10	0000	21.0	5.2	36	441	8.60	140	0.080	0.090	0.029	0.014
72/08/29	09 00	0000			60	360	8.40	149	0.060	0.080	0.052	0.028
	09 00	0004	20.0	9.3		360	8.35	150	0.040	0.060	0.033	0.016
	09 00	0015	14.5	4.0		380	7.80	151	0.040	0.110	0.021	0.011
	09 00	0023	10.0	1.6		380	7.70	147	0.040	0.190	0.026	0.006
72/10/26	13 00	0000			60	420	8.00	182	0.090	0.130	0.052	0.035
	13 00	0004	6.7	11.7		420	8.10	181	0.080	0.140	0.052	0.034
	13 00	0015	6.7			420	8.10	182	0.080	0.130	0.059	0.035
	13 00	0023	6.5			410	8.10	182	0.080	0.140	0.053	0.038
72/10/27	16 35	0000			86	410	8.00	173	0.070	0.120	0.041	0.026
	16 35	0004	7.1	11.2		410	8.00	168	0.050	0.120	0.040	0.026
	16 35	0015	7.0	11.0		410	8.00	168	0.050	0.120	0.045	0.027
	16 35	0025	7.0	11.2		410	8.00	161	0.060	0.110	0.048	0.029
	16 35	0034	7.1	11.0		410	8.00	163	0.050	0.110	0.050	0.029

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLOPHYL A UG/L
72/08/29	09 00	0000	2.0J
72/10/26	13 00	0000	20.4J
72/10/27	16 35	0000	20.8J

J VALUE KNOWN TO BE IN ERROR

APPENDIX C

TRIBUTARY and WASTEWATER TREATMENT PLANT DATA

STORET RETRIEVAL DATE 74/10/10

2716A1 LS2716A1
45 20 00.0 094 07 00.0
CLEARWATER RIVER
27 15 ANNANDALE
O/CLEARWATER LAKE
BRDG BETWEEN GRASS LK AND CLEARWATER LK
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/14	10 10		0.034	1.000	0.058	0.005K	0.027
72/11/11	09 20		0.065	0.790	0.110	0.015	0.045
72/12/09	09 30		0.054	0.960	0.088	0.119	
73/01/06	09 20		0.029	1.000	0.062	0.005K	0.022
73/02/03	09 35		0.054	1.080	0.096	0.016	0.025
73/03/11	09 30		0.115	1.300	0.056	0.005K	0.025
73/04/07	09 00		0.168	1.400	0.042	0.012	0.105
73/04/17	08 20		0.010K	1.100	0.011	0.008	0.060
73/05/05	09 15		0.010K	1.200	0.022		0.060
73/06/10	09 50		0.010K	1.300	0.014	0.005K	0.035
73/07/14	09 30		0.010K	1.100	0.016	0.005K	0.020
73/08/11	09 45		0.010K	1.200	0.019	0.005K	0.025
73/10/03	10 00		0.010K	1.500	0.072	0.006	0.035

K VALUE KNOWN TO BE LESS
THAN INDICATED

STORET RETRIEVAL DATE 74/10/30

2716A2 LS2716A2
45 18 30.0 094 09 30.0
CLEARWATER RIVER
27 15 ANNANDALE
T/CLEARWATER LAKE
BRDG BETWEEN LK AUGUSTA ANDCLEARWATER LK
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/14	10	35	0.075	1.615	0.115	0.176	0.240
72/11/11	09	50	0.182	1.890	0.580	0.350	0.410
72/12/09	10	45	0.357	1.930	0.510	0.330	0.370
73/01/06	10	20	0.610	1.900	0.440	0.290	0.300
73/02/03	10	30	0.780	1.470	0.399	0.260	0.280
73/03/11	10	20	0.900	1.540	0.440	0.230	0.270
73/04/07	10	30	0.880	2.100	0.370	0.231	0.330
73/04/17	08	50	0.280	1.540	0.168	0.170	0.240
73/05/05	08	40	0.280	2.310	0.170	0.176	0.230
73/06/10	10	40	0.010K	1.400	0.015	0.164	0.250
73/07/14	10	10	0.012	2.000	0.080	0.015	0.085
73/08/11	10	30	0.010K	2.560	0.022	0.022	0.135
73/10/03	10	16	0.038	1.950	0.138	0.040	0.120

K VALUE KNOWN TO BE LESS
THAN INDICATED

STORET RETRIEVAL DATE 74/10/30

271681 LS271681
49 15 00.0 094 09 30.0
THREEMILE CREEK
27 15 ANNANDALE
T/CLEARWATER LAKE
CO HWY 44 XING E OF FAIRHAVEN
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/14	10	25	0.220	0.850	0.069	0.013	0.035
72/11/11	09	35	0.280	0.850	0.066	0.011	0.030
72/12/09	10	15	0.650	0.880	0.168	0.013	0.026
73/01/06	09	50	0.700	0.960	0.140	0.009	0.050
73/02/03	10	10	0.830	0.540	0.110	0.023	0.040
73/03/11	11	00	0.520	2.200	0.378	0.105	0.220
73/04/06	07	45	0.240	1.180	0.036	0.010	0.040
73/04/17	10	20	0.160	0.910	0.029	0.010	0.030
73/05/05	09	15	0.158	1.540	0.036		0.030
73/06/10	10	15	0.150	0.880	0.040	0.021	0.065
73/07/14	09	45	0.280	0.700	0.046	0.026	0.055
73/08/11	10	00	0.160	0.500	0.036	0.024	0.050
73/10/03	08	59	0.150	0.840	0.044	0.018	0.055

STORET RETRIEVAL DATE 74/10/30

2716C1 LS2716C1
45 18 30.0 094 18 00.0
WILLOW CREEK
27 7.5 KIMBALL
T/CLEARWATER LAKE
ST HWY 15/24 XING ABOVE KIMBALL STP
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/14	11	55	0.517	1.000	0.089	0.020	0.042
72/11/11	10	20	0.348	0.960	0.088	0.020	0.038
72/12/09			1.360	0.960	0.126	0.006	0.021
73/02/03	11	15	2.500	0.770	0.231	0.011	0.035
73/03/11	10	00	0.580	5.600	1.470	0.450	0.810
73/04/07	11	30	0.200	1.150	0.013	0.011	0.030
73/04/17	10	50	0.280	1.150	0.015	0.016	0.045
73/05/05	10	40	0.295	1.760	0.031	0.023	0.040
73/06/10	11	40	0.420	1.500	0.030	0.058	0.157
73/07/14	11	00	2.060	1.080	0.100	0.019	0.055
73/08/11	11	30	2.020	0.840	0.086	0.018	0.060

STORET RETRIEVAL DATE 74/10/30

2716D1 LS2716D1
45 18 30.0 094 24 30.0
COUNTY DITCH #20
27 7.5 WATKINS
T/CLEARWATER LAKE
ST HWY 55 XING ABOVE WATKINS STP
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/14	12 15		0.630	2.900	0.380	0.200	0.260
72/11/11	10 30		1.600	2.800	0.048	0.410	1.050
73/04/07	11 10		0.190	6.100	1.680	1.970	2.970
73/04/17	11 40		1.500	3.500	0.770	1.300	1.570
73/05/05	11 15		1.580	4.800	0.870	1.300	1.570
73/06/09	09 50		0.010K	5.000	1.700	1.580	2.100
73/07/14	09 40		0.054	11.000	7.500	4.200	5.200
73/08/11	08 13		0.825	5.500	2.575	2.600	4.400
73/10/03	08 05		0.120	9.500	5.400	4.600	6.100

K VALUE KNOWN TO BE LESS
THAN INDICATED

STORET RETRIEVAL DATE 74/10/30

271602 LS271602
45 18 00.0 094 24 00.0
COUNTY DITCH #20
27 7.5 WATKINS
T/CLEARWATER LAKE
RD XING 1 MI SSE OF WATKINSBELO STP
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/14	12 25		0.760	1.375	0.105	0.090	0.175
72/11/11	10 20		0.975	1.600	0.012	0.360	0.760
72/12/04	09 55		0.066	6.400	3.800	2.200	7.150
73/04/07	10 55		0.028	22.000	0.073	11.100	
73/04/17	11 10		0.148	5.000	1.700	2.900	3.150
73/05/05	11 50		0.210	4.500	1.890	3.000	3.150
73/06/09	08 20		0.138	5.400	3.100	4.200	4.400
73/07/14	08 45		0.050	15.000	10.400	4.600	6.200
73/08/11	08 33		0.092	7.200	2.600	4.300	5.000
73/10/03	09 40		0.670	12.500	8.400	7.930	7.930

STORET RETRIEVAL DATE 74/10/10

2716E1 LS2716E1
45 15 00.0 094 06 00.0
UNNAMED TRIB TO SE END OF LAKE
27 15 ANNANDALE
T/CLEARWATER LAKE
ST HWY 55 1 MI ESE ANNANDALE ABOVE STP
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/14	11	15	0.130	0.975	0.105	0.008	0.032
72/11/11	08	35	0.195	0.840	0.005K	0.009	0.025
72/12/09	08	15	0.063	0.970	0.170	0.007	0.034
73/01/06	07	45	0.160	1.980	0.540	0.005K	0.095
73/02/03	08	00	0.070	2.100	0.550	0.008	0.165
73/03/11	09	00	0.550	2.200	0.270	0.100	0.270
73/04/07	09	50	0.093	2.310	0.115	0.013	0.045
73/04/17	09	20	0.031	1.150	0.017	0.015	0.045
73/05/05	09	50	0.034	0.890	0.019	0.021	0.040
73/06/10	08	20	0.014	2.000	0.105	0.031	0.160
73/07/14	09	00	0.022	2.600	0.420	0.046	0.307
73/08/11	08	00	0.067	2.700	0.030	0.021	0.120
73/10/03	08	45	0.016	1.900	0.220	0.048	0.200

K VALUE KNOWN TO BE LESS
THAN INDICATED

STORET RETRIEVAL DATE 74/10/30

2716E2 LS2716E2
45 17 00.0 094 05 00.0
UNNAMED TRIB TO SE END OF LAKE
27 15 ANNANDALE
T/CLEARWATER LAKE
ST HWY 24 XING RELO ANNANDALE STP
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/14	10 58		0.078	1.000	0.066	0.039	0.080
72/11/11	08 50		0.200	1.200	0.012	0.060	0.094
72/12/04	08 40		0.094	0.915	0.082	0.018	0.050
73/01/08	08 30		0.085	1.150	0.100	0.017	0.040
73/02/03	08 40		0.140	1.010	0.110	0.014	0.035
73/03/11	08 30		0.940	6.090	1.000	0.198	1.000
73/04/06	08 10		0.056	2.100	0.050	0.007	0.055
73/04/17	09 55		0.042	1.100	0.042	0.022	0.085
73/05/05	10 15		0.048	1.300	0.063	0.023	0.065
73/06/10	09 10		0.033	1.100	0.030	0.025	0.055
73/07/14	09 15		0.240	2.300	0.093	0.056	0.080
73/08/11	08 40		0.470	1.320	0.110	0.084	0.135
73/10/03	09 15		0.150	1.150	0.058	0.100	0.210

STORET RETRIEVAL DATE 74/10/30

271651 TF271651 P000785
45 18 30.0 094 24 30.0
WATKINS
27 7.5 WATKINS
T/CLEARWATER LAKE
CO DITCH # 20
11EPALES 2141204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
73/07/19	11 00								
CP(T)-			1.600	33.000	15.800	5.800	11.500	0.200	0.200
73/07/19	13 00								
73/08/23			2.380	11.000	0.039	3.000	3.800	0.200	0.200
73/10/04	11 00		1.540	27.000	6.900	3.150	8.300	0.200	0.200
74/01/08	15 00		2.000	26.000	12.000	7.300	12.500	0.200	0.200
74/02/05	15 30		2.400	18.000	13.100	7.830	10.500	0.200	0.200
74/04/01	14 30		1.280	17.000	0.470	2.500	8.500	0.200	0.200
74/05/01	09 00		2.600	17.000	0.270	2.500	3.800	0.200	0.200
74/06/18	10 30		5.040	16.000	1.000	2.630	4.200	0.200	0.200
74/07/23	09 30			21.000	3.450	4.100	6.800	0.200	0.200
74/08/05	08 20		8.800	9.000	0.058	4.800	5.900	0.200	0.200
74/09/05	08 25		0.040	28.000	9.900	6.300	9.600	0.200	0.200